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10 February 1964

RESEARCH OBJECTIVE

MULTI-SENSOR IMAGERY RESEARCH: (Around-the-Clock Aerial Surveillance of
Target Activity Levels in a Suspected Military Build-up)

(PHASE I)

1. INTRODUCTION.

Research is proposed to determine the most effective techniques of using sequential day and night imagery (from a combination of camera and [] scanner) to determine changes in target activity. More specifically, the proposed project would seek to simulate acquisition and analysis of changing activity levels of certain targets which are indicators of military "build-up." It should be emphasized that this research is not directed toward imagery acquisition methods, but to the problem of imagery analyses and exploitation techniques. The acquisition phase of this project would provide imagery taken under rigidly controlled conditions -- to be used in developing objective exploitation techniques.

[] sensors have been flown over numerous targets to determine sensor effectiveness in general-purpose detection and identification. These studies have shown that, [] scanners are capable of acquiring imagery which has sufficient resolution to identify most targets of military interest. None of the projects, however, have demonstrated that [] can be effectively related to photography obtained a few hours earlier. However, it now appears that this could be one of the more obvious uses of [] scanners in the near future: for, correct analysis of daylight photography plus [] [] over the same targets would be an ideal method of continual, around-the-clock surveillance of an area of suspected military "build-up." Yet, to date, there is little objective knowledge about the quantity or reliability of data which can be interpreted from [] imagery under these circumstances. Furthermore, there is little knowledge about the additive intelligence value of the [] "history" of a suspect target over a period of a week or so. It is suspected that activity-level interpretation can be improved considerably by this additive [] information.

2. CONCEPT.

2.1. Purpose. There are two primary objectives of the proposed research:

2.1.1. To determine the significance and value of [] in augmenting conventional aerial photography as they both might be used for determining the location and rate of military activity over a period of time;

2.1.2. To devise guidelines that will assist interpreters in their use of sequential photo [] for military "build-up" analyses.

2.2. Scope. This project will encompass several separate but coherent activities, as listed below:

2.2.1. Data Acquisition: Collection of aerial photography, [] imagery and complete ground truth of seven targets over a period of seven days and nights.

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2.2.2. Imagery Interpretation: Detailed interpretation of targets' activity on aerial photography alone and then on photography and [] imagery in the sequence flown, but without ground truth.

2.2.3. Data Analysis: Comparison of interpreted data with ground truth data to determine the significance and additive value of infrared for target activity-level analysis.

2.2.4. Methods Development: Derivation and presentation of guidelines to assist interpreters of sequential imagery in their analysis of target activity levels and military build-up.

There is strong opinion that the tasks required for the data acquisition phase of this project should be performed separately and by a group other than the one performing the subsequent interpretation, analysis, and methods development tasks. This will not only assure complete objectivity of conclusions but will more nearly simulate actual operational conditions. Therefore, the imagery interpretation, data analysis, and methods development phases will be performed in-house and/or by a separate contractor. Only those requirements relating to the data acquisition phase are listed below.

3. SPECIFICATIONS.

3.1. Data Acquisition Requirements.

3.1.1. Aircraft. The contractor shall provide an aircraft and crew capable of fulfilling the project requirements as stated below.

3.1.2. Aerial Photography. Complete vertical photographic coverage of each target area shall be obtained between 0900 hours and 1500 hours (local time) each day for seven consecutive days.

The camera used must be a high quality reconnaissance or cartographic type capable of providing large scale (1:5000 or larger) high quality photography.

Since stereo is essential, 60% forward overlap is a rigid requirement. If more than one flight-line is necessary to cover a target, side-lap coverage should be at least 10% of the format width.

A ground resolution target shall be photographed each day at some point of that day's flight.

The film shall be a high-quality panchromatic emulsion. A gray-level step wedge shall be attached to the end of each roll of unexposed film as an aid for calibrating subsequent processing. Film shall be processed according to high-quality laboratory procedures. One complete set of negatives, duplicate positive transparencies and paper prints shall be delivered. All photography shall be adequately identified and titled with target, date, time and altitude of acquisition. Accurate flight-line plots shall accompany all photography.

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3.1.4. Ground Truth Data. In order to fulfill the research objectives, it is extremely important that complete, accurate, and fully documented data on the actual target conditions be gathered at the time of imagery acquisition. It is realized that collection of the necessary ground truth is a difficult task and requires considerable personnel commitment; however, this data is probably the most essential information for objective analysis of the total problem. Listed below are the required essentials of ground truth:

3.1.4.1. Complete U. S. Weather Bureau hourly reports from the weather station(s) nearest the area of targets. These reports shall cover a period from 24 hours prior to the first infrared mission through, and including, the last infrared mission. They should include at least: air temperature, precipitation, wind, cloud cover present, cloud levels and dew point. Also to be included are the times of official sunset and sunrise for each day of operation.

3.1.4.2. Target temperatures with radiometers. This would include the surface temperatures of selected target components, background surface temperatures adjacent to measured target components, and ambient air temperatures. These temperatures should be measured for the seven nights at approximately the same time as the [] overflight in each target area (plus or minus one hour).

3.1.4.3. Flash photographs and description of target elements which have changed since the last [] mission.

3.1.4.4. Port Authority logs, airport logs, and other similar target data which is normally maintained on the status of the various target areas.

3.1.4.5. A full analysis of all exposed materials in each target area. This should be accomplished before imagery acquisition since this data would be quite useful in planning the location of subsequent temperature measurement. These analyses should result in seven target maps (color-coded or zip-coded) to indicate the different surface materials in each target area. ("Materials" are defined as: concrete roof, aluminum roof, sod, grass, soil, blacktop road, water, etc.)

3.1.4.6. Complete documentation of all ground truth data which has been collected shall be presented in the final technical report along with a description of the acquisition of all photography and [] imagery. All parameters of each flight of photography and imagery -- e.g., time over each target, altitude, etc. -- should be identified. A complete description of the technical characteristics of the camera and the [] scanner, as well as a description of how each roll of film was developed and reproduced, shall be included. Three copies of the final Technical Report are required.

3.1.4.7. All photography, [] imagery, and ground truth data shall become the property of the United States Government.

3.1.5. Targets. There are seven target types which are considered as representative of military "build-up" indicators. The target types are:

3.1.5.1. a port and its associated facilities

3.1.5.2. a large railroad yard

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- 3.1.5.3. a civilian airport
- 3.1.5.4. a storage depot
- 3.1.5.5. a trucking terminal
- 3.1.5.6. a military motor pool
- 3.1.5.7. an unspecified facility or installation under rapid construction

Proposals for the data acquisition should include recommendations of specific, existing installations of the above types. Final selection and delineation of installations to be used in this project shall be approved by the Government Project Monitor. For maximum efficiency of aircraft time and ground truth collection, the selected installations should each be characteristic of their type yet compact in area. And, it would be advantageous if they should all be in the same approximate area (such as in one metropolitan area). They should also be installations with some degree of activity around-the-clock -- preferably with changing rates of activity.

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10 January 1963

RESEARCH OBJECTIVE**MULTI-SENSOR IMAGERY RESEARCH:** (Around-the-Clock Aerial Surveillance of Target Activity Levels in a Suspected Military Build-up)1. **INTRODUCTION.**

Research is proposed to determine the most effective techniques of using sequential day and night imagery (from a combination of camera and [] to determine changes in target activity. More specifically, the proposed project would seek to simulate acquisition and analysis of changing activity levels of certain targets which are indicators of military "build-up." It should be emphasized that this research is not directed toward imagery acquisition methods, but to the problem of imagery analyses and exploitation techniques. The acquisition phase of this project would provide imagery taken under rigidly controlled conditions -- to be used in developing objective exploitation techniques.

[] sensors have been flown over numerous targets to determine sensor effectiveness in general-purpose detection and identification. These studies have shown that, at night, [] scanners are capable of acquiring imagery which has sufficient resolution to identify most targets of military interest. None of the projects, however, have demonstrated that night [] imagery can be effectively related to photography obtained a few hours earlier. However, it now appears that this could be one of the more obvious uses of [] scanners in the near future: for, correct analysis of daylight photography plus night time [] imagery over the same targets would be an ideal method of continual, around-the-clock surveillance of an area of suspected military "build-up." Yet, to date, there is little objective knowledge about the quantity or reliability of data which can be interpreted from [] imagery under these circumstances. Furthermore, there is little knowledge about the additive intelligence value of the [] "history" of a suspect target over a period of a week or so. It is suspected that activity-level interpretation can be improved considerably by this additive [] information.

2. **CONCEPT.**

2.1. **Purpose.** There are two primary objectives of the proposed research:

2.1.1. To determine the significance and value of [] in augmenting conventional aerial photography as they both might be used for determining the location and rate of military activity over a period of time;

2.1.2. To devise guidelines that will assist interpreters in their use of sequential photo/[] for military "build-up" analyses.

2.2. **Scope.** This project would encompass several separate but coherent activities, as listed below:

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2.2.1. Data Acquisition: Collection of aerial photography, [] imagery and complete ground truth of seven targets over a period of seven days and nights.

2.2.2. Imagery Interpretation: Detailed interpretation of targets' activity on aerial photography alone and then on photography and [] imagery in the sequence flown, but without ground truth.

2.2.3. Data Analysis: Comparison of interpreted data with ground truth data to determine the significance and additive value of [] for target activity-level analysis.

2.2.4. Methods Development: Derivation and presentation of guidelines to assist interpreters of sequential imagery in their analysis of target activity levels and military build-up.

There is strong opinion that the tasks required for the data acquisition phase of this project should be performed separately and by a group other than the one performing the subsequent interpretation, analysis, and methods development tasks. This will not only assure complete objectivity of conclusions but will more nearly simulate actual operational conditions. It could be accomplished by two individual contractors or a contractor-sub-contractor arrangement -- implying that parties interested in participation should select either the acquisition phase or the three subsequent tasks and submit proposals accordingly.

A good [] scanner is not available to this sponsor for issue as GFE for the research. It is therefore assumed that potential bidders for the acquisition of airborne and ground data will have available a state-of-the-art [] scanner for use on this project.

3. REQUIREMENTS.

3.1. Data Acquisition Requirements.

3.1.1. Aircraft. The contractor would provide an aircraft and crew capable of fulfilling the project requirements as stated below.

3.1.2. Aerial Photography. Complete vertical photographic coverage of each target area shall be obtained between 0900 hours and 1500 hours (local time) each day for seven consecutive days.

The camera used must provide photography with both large scale (1:5000 or larger) and wide lateral coverage (80° or more). 70mm format is preferable but consideration of scale, altitude, focal length and field angle of the lens would make larger formats acceptable.

Since stereo is essential, 60% forward overlap is a rigid requirement. If more than one flight-line is necessary to cover a target, side-lap coverage should be at least 10% of the format width.

A ground resolution target shall be photographed each day at some point of that day's flight.

The film shall be a high-quality panchromatic emulsion. A gray-level step wedge shall be attached to the end of each roll of unexposed film as an aid for calibrating subsequent processing. Film shall be processed according to high-quality laboratory procedures. One complete set of negatives, duplicate positive transparencies and paper prints shall be delivered. All photography shall be adequately identified and titled with target, date, time and altitude of acquisition. Accurate flight-line plots shall accompany all photography.

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3.1.4. Ground Truth Data. In order to fulfill the research objectives, it is extremely important that complete, accurate, and fully documented data on the actual target conditions be gathered at the time of imagery acquisition. It is realized that although collection of the necessary ground truth is a difficult task, this data is probably the most essential information for objective analysis of the total problem. Listed below are the required essentials of ground truth:

3.1.4.1. Complete U. S. Weather Bureau hourly reports from the weather station(s) nearest the area of targets. These reports shall cover a period from 24 hours prior to the first [] mission through, and including, the last [] mission. They should include at least: temperature, precipitation, wind, cloud cover present, cloud levels and dew point.

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3.1.4.3. Flash photographs and description of target elements which have changed since the last [] mission.

3.1.4.4. Port Authority logs, airport logs, and other similar target data which is normally maintained on the status of the various target areas.

3.1.4.5. A full analysis of all exposed materials in each target area. This should be accomplished before imagery acquisition since this data would be quite useful in planning the location of subsequent temperature measurement. These analyses should result in seven target maps (color-coded or zip-coded) to indicate the different surface materials in each target area. ("Materials" are defined as: concrete roof, aluminum roof, sod, grass, soil, blacktop road, water, etc.).

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3.1.4.6. Complete documentation of all ground truth data which has been collected shall be presented in the technical report along with a description of the acquisition of all photography [] All parameters of each flight of photography and imagery -- e.g., time over each target, altitude, etc. -- should be identified. A complete description of the technical characteristics of the camera and the [] scanner, as well as a description of how each roll of film was developed and reproduced, shall be included.

3.1.4.7. All photography, [] and ground truth data shall become the property of the United States Government.

3.1.5. Targets. Specific targets for this research will not be selected until initiation of the project. There are seven target types, however, which are considered as representative of military "build-up" indicators. Since these types are rather common in many areas of the United States, selection of specific installations can be made after the contract is awarded. Maximum efficiency in use of aircraft and personnel would be attained if the specific targets were near the contractor's base of operations. The target types are:

- 3.1.5.1. a port and its associated facilities
- 3.1.5.2. a large railroad yard
- 3.1.5.3. a civilian airport
- 3.1.5.4. a storage depot
- 3.1.5.5. a trucking terminal
- 3.1.5.6. a military motor pool
- 3.1.5.7. an unspecified facility or installation under rapid construction.

Proposals for the data acquisition phase should include recommendations of specific, existing installations of the above types. For maximum efficiency of aircraft time and ground truth collection, the selected installations should each be characteristic of their type yet compact in area. And, it would be advantageous if they should all be in the same approximate area (such as in one metropolitan area). They should also be installations with some degree of activity around-the-clock -- preferably with changing rates of activity.

3.2. Imagery Interpretation Requirements.

3.2.1. Photographic Interpretation. A detailed interpretation of all daylight aerial photography of all targets shall be conducted without reference to ground truth or [] imagery. This task shall be performed in the same sequence as the photography was acquired and will consist of a complete inventory of all elements, within the defined target areas, which are indicative of activity levels of the installations. For example, the interpretations of a port should include the number and types of ships in port -- their location and types of cargo on board, if evident; number and types of off-loading equipment; amount and type of material in off-loading areas; etc. Thus, the interpretation of this port on seven days of photo coverage should yield a history of daylight activity for that week. All interpreted data should be tabulated so that comparisons can easily be made from day to day. In addition ground resolution of all photo coverages should be measured from the imaged resolution target.

3.2.2. Sequential Interpretation. This task is essentially the same as the previous photo interpretation except that all coverage (photo and []) will be interpreted in sequence of time acquired. (This is also to be accomplished without ground truth data.) In order to be as objective as possible during this phase, the photography should be re-interpreted in

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25X1 proper sequence with the [] without benefit of the results of previous photo interpretation: the interpreted [] data may possibly influence succeeding photo interpretation of the target. All interpreted inventory data shall be tabulated so that activity is easily comparable on a day-to-day basis. Ground resolution of the [] imagery should be closely estimated on all [] coverages.

25X1 3.3. Data Analysis Requirements. Analysis of accumulated data at this stage of the project should be designed to satisfy three objectives:

25X1 3.3.1. to determine the relative intelligence outputs of "day only" interpretation vs day and night interpretation. This can be achieved by comparing the initial photo interpretation data against the sequential photo/[] data;

25X1 3.3.2. to determine the total effectiveness of night [] for inventory of activity level indicators. This can be accomplished by a comparison of interpreted [] data with ground truth;

25X1 3.3.3. to determine the intelligence significance of the thermal "histories" of certain target elements.

It is hoped that this data analysis phase can be so designed that the results can be compared as objectively as possible. However, since the seven targets are dynamic in nature and will undergo many changes over a period of a week, in many cases strict comparison of sequential imagery of the same objects will not be possible. In these cases, it is probably valid to subjectively compare imagery of similar objects on a "best judgment" basis. All data and the results of data analysis should be incorporated into an interim technical report.

25X1 3.4. Methods Development Requirements. As a result of the knowledge gained during the interpretation and analysis phases, an interpretation manual shall be produced. This manual should be suitable as a training and reference source for qualified photographic interpreters who have little knowledge or experience with night [] imagery. Accordingly, it should include an introductory section on simplified [] physics, [] equipment and on the characteristics of [] imagery in general. The main section of the manual shall consist of guidelines for interpreting activity levels of build-up indicator targets on sequential day and night photography and [] imagery. The final design, content, and format of the manual shall be subject to approval of the Government contract monitor.

25X1 Fifty (50) copies of this manual are required. All continuous-tone illustrations shall be photographically reproduced so as to retain maximum resolution and clarity.

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